JPRS-TND-88-014
13 JULY 1988

JPRS Report

Nuclear Developments

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ARGENTINA

Nigeria Interested in Buying Nuclear Plant

PY2306172788 Buenos Aires NOTICIAS ARGENTINAS in Spanish 1542 GMT 23 Jun 88

[Text] Buenos Aires, 23 Jun (NA)—Argentina and Nigeria will hold talks on signing, in the next few months, a cooperation agreement that would allow, among other things, the sale of an experimental nuclear reactor to Nigeria.

Reliable diplomatic sources told NA that Nigerian Science and Technology Minister Emmanuel Emovon this week met with Foreign Minister Dante Caputo to evaluate bilateral relations.

It was agreed on this occasion that the Nigerian foreign minister, who represents one of the most important sub-Saharan countries, will come to this country in 2 weeks to sign the Argentine-Nigerian agreement.

Emovon, who is making his first visit to Latin America, "was very impressed" by the development of the Argentine nuclear technology, said the source.

Minister Emovon, who is a prominent chemist in his country, visited the Bariloche nuclear plant, the INTA [National Institute of Agricultural-Livestock Technology], and the Ezeiza Pilot Plant for Reprocessing Fuel Elements.

CNEA Head Denies Nuclear Waste Site Chosen

PY1506181988 Buenos Aires TELAM in Spanish 1352 GMT 15 Jun 88

[Text] Buenos Aires, 15 Jun (TELAM)—CNEA chairperson Emma Perez Ferreira has expressed her astonishment regarding a report published by the British economic newspaper THE FINANCIAL TIMES regarding the establishment of a nuclear waste site in the Town of Gastre, Chubut Province. Perez Ferreira has asserted that there is no imminent need for adopting a measure of this nature.

After stating this is a political measure completely outside the bounds of the technical decisions adopted by the CNEA, Perez Ferreira said no political party will be willing to pay the high political cost of accepting a nuclear waste site.

The scientist explained that according to the national nuclear energy production program, a nuclear dump with the characteristics mentioned in the report will be needed only by the year 2005.

She said that for the past 10 years, the CNEA has been studying possible geological sites to establish a nuclear deposit [repostorio] for its own material so as not to affect the local radioactivity level in populated areas.

Perez Ferreira explained the difference between a nuclear waste site and a nuclear deposit. She said the latter is a place where previously treated and reprocessed nuclear waste is deposited to assure that there will be no incidence in the radioactivity level that is normally found in the soil.

CNEA Must Be Restructured, Says Writer

51002025 Buenos Aires LA PRENSA in Spanish 25 May 88 p 8

[Commentary by Miguel J. Culaciati: "Atomic Energy"]

[Text] Little by little, as the wheels of democracy have begun to turn in our midst, the heavy veils of mystery with which the bureaucracy has been protecting its richly endowed fiefdoms for 40 years have been lifted. We Argentines are now learning with an astonishment bordering on incredulity that some of these monsters have cost the people no less than $48 billion in two decades time.

This huge sum of money, with which we could have unquestionably built a much more stable state and a much happier society, does not include the $20 billion in foreign debt contracted by the so-called "nuclear plan." Nonetheless, only a minimal portion of the program has been carried out, and it remains mired in an ongoing predicament that prompts justified concern over the degree of nuclear safety.

But lest I lapse into the sort of overused and futile criticism that overwhelms and paralyzes, inasmuch as a discussion of the past is of little use except to stop us from making the same mistakes, I will say that in my opinion the important thing is to salvage most of the positive efforts that have been made and to free ourselves from the millstone of imprisoning structures. The basic problems in atomic energy are: state nationalism, monopoly, uncontrolled centralism and the cartel of supplier firms.

State nationalism forced us, for the sake of so-called nuclear autonomy, which was never achieved, to opt for natural uranium, which has been abandoned by all countries today except Canada, thus arousing suspicions that we were embarking on a nuclear arms race, which is something that undoubtedly passed through the minds of several CNEA [National Commission for Atomic Energy] administrations during eras that are now happily behind us. Today the public is still being deceived with these banners. What is being concealed is that almost all of our nuclear facilities, including the two nuclear power plants, are subject to international inspections. Even worse, if a screw breaks at Atucha or Embalse, we have to turn to foreign suppliers who export items only under use supervision by inspectors from the International Atomic Energy Agency. By pursuing this mistaken policy we are depriving ourselves of economical and modern nuclear technologies. This is why we have not yet ratified the nuclear nonproliferation and

Tlatelolco treaties, which when all is said and done and to the extent possible, considering the enormous difficulties, seek only to prevent countries from manufacturing and exporting nuclear weapons, in other words, the equivalent of the nuclear holocaust that we so fear. The country must ratify at least the Tlatelolco Treaty and seriously study the Nuclear Nonproliferation Treaty, because only thus will we join the developed world.

So-called nuclear exports are as dangerous politically (Libya, Iran, etc.) as they are disadvantageous economically (the pilot plant for Peru), which does not mean that after our treaty policy has changed we cannot then start competing with what we produce on an equal footing.

Anything else would merely be continuing our "single-minded" approach, and to make matters worse, in our strategic situation we cannot afford any more nonsensical adventures. Being a nationalist today means joining the developed world, because this is the only way to defend the nation.

Moreover, nuclear activity has been state-controlled from the beginning. Only the state has been involved in this field and only the state and its officials have decided what it behooves us to do in accordance with strict planning that is totally divorced from the laws of the marketplace.

How to end the government's monopoly and privatize atomic activity as much as possible without putting the population at risk?

Privatization

As is the case in the United States, the CNEA must of course continue to monitor safety at all nuclear facilities in the country. Nonetheless, atomic energy generation can be decentralized and privatized. At present it functions within the CNEA as an independent administrative unit called the "department of nuclear power plants."

The commission sells the electricity that it produces at an unrealistically low price to the national power grid and to SEGBA [Greater Buenos Aires Electrical Services], which, moreover, does not collect on time. Electricity prices have been set far lower than international levels to justify politically the need to build power plants of this type; this assertion can be readily verified by analyzing the comparative world situation.

In turn, the CNEA hired the firm ENASE as its sole contractor to build the Atucha 2 power plant and the heavy-water plant. The KWU Siemens group owns one-quarter of the share capital in ENASE, and the state holds three-quarters.

Other countries with similar statism problems, such as South Africa, for example, have privatized nuclear power generation or are making a serious effort to do so. We could easily privatize energy production by renting out the power plants or else decentralize operations by setting up corporations for each one; the governments of the provinces in which they are located could be involved in these corporations, receiving part of the share capital as compensation for the use of their waters, lands and natural spaces.

Semi-Autonomous Sectors

As has been said, there are two semi-autonomous sectors: the Directorate of Nuclear Power Plants and the company ENASE. The former runs the power plants and sells the energy; the latter builds or rather manages the construction of a nuclear power plant and the heavy-water plant. In neither of these important sections, because that is what are, are there representatives of the provinces. The same goes for the Board of Directors of the CNEA, which is made up of longstanding employees of the bureaucracy and one or another political friend. It is answerable solely to the president, and there is no congressional monitoring whatsoever, not even over safety levels, because the commission oversees itself....

When the bureaucracy acquires such great power, its business partners inevitably appear to vie for the huge construction, assembly and supply contracts. These companies, of which there are very few, protect each other by creating a system of standards that practically prevents any firm outside the "cartel" from taking part in CNEA competitive biddings.

If an in-depth investigation is ever conducted, it will no doubt reveal cases such as the famous railway conductor's uniform that cost National Railways no less than $400.

Consequently, the CNEA must urgently be restructured, precisely to rescue it from the collapse threatening it, given the huge commitments that it has made, the lack of funding and the delays by other government agencies in paying for the low-priced energy that it produces. The measures that I regard as most urgent are an overhaul of the CNEA Board of Directors leading to an active role for provinces, like Cordoba, that have major nuclear facilities within their borders; an immediate study of the privatization of nuclear power generation (Atucha I and Embalse) under CNEA safety monitoring; ratification of the international treaties; an agreement for the sale of ENASE's share block to Siemens or to a third party; and a general reassessment of the nuclear plan that will no doubt come up with a way to complete the projects under way that can no longer be halted, such as Atucha II and the heavy-water plant. The CNEA would thus become what it ought to be: an agency for investigating, developing, educating about and monitoring nuclear activity, and it could take advantage of its export capacity, independently if possible or in association with other Argentine firms, in accordance with the international standards that seek to prevent nuclear proliferation.

8743

CNEA Moves Toward Restructuring

51002026b Buenos Aires CLARIN in Spanish
1 Jun 88 p 24

[Text] The continuity of the two main projects in the nuclear plan is worrying the authorities from the National Commission for Atomic Energy [CNEA]. Although the agency succeeded in closing the budget accounts with the Ministry of Economy, it has yet to reach an agreement for additional external financing to be provided by the Federal Republic of Germany, whose enterprise, Kraftwerk Union [KWU], is participating in the construction of the Atucha II atomic power plant.

Last week, a mission from the Argentine nuclear agency opened the negotiations in the FRG to obtain loans that would supplement the funds pledged by the National Treasury. Whether CNEA will gain access to another foreign loan to finish the heavy water industrial plant (a project all but 10 percent completed, an option now offered by the main contracting consortium, will also depend on the success accrued in these negotiations. Dr Emma Perez Ferreira, head of the atomic agency, preferred to be cautious in assessing the negotiations. "We cannot speak of success yet, because the discussions with the Germans must be supported by crystal clarity in the accounts and the costs of the as yet uncompleted projects; and this requires a study that has just begun." Nevertheless, she noted that, by July, "that examination will have been completed, and then we shall have a response for the question."

She also made it clear that, if the results anticipated from these talks are not attained, the projects will be brought to a standstill. She observed in her dialogue with CLARIN that the reasons "lie in our decision not to continue paying unproductive costs stemming from the slow work pace."

Then she remarked that, once "this situation has been resolved," it will be a priority to make changes in the CNEA structure, making it possible to devote to the projects "all the attention that they require." This reorganization could affect both the Nuclear Enterprise for Electrical Power Plants (ENACE), a mixed entity set up by the commission and the German firm, KWU, and the Directorate of Nuclear Power Plants; which are directly linked with the third nuclear electric power plant. The official claimed: "The idea that we are discussing is to have that plan made directly subordinate to the agency president's office."

The reasons prompting these changes are related to the necessity for ensuring "maximum efficiency of the investments." Dr Perez Ferreira seems ready to head directly all the discussions that will take place following the possible agreement with the German financiers.

To the latter, the topic of the costs of local supplies is not an issue. Hence, the commission's authorities have started opening the umbrella: "We are not willing to pay prices far higher than the international ones, or to agree that supplies be provided over time periods that are too long," they warn. This approach has unquestionably had repercussions on local business circles. They suspect that this premise might have as a corollary a gradual replacement of goods and services contracted in the country by others coming from abroad.

Although Emma Perez Ferreira emphatically maintained that the negotiations for German financing "do not imply any type of conditions," the industrialists' fears are not groundless. Everything suggests that, at the least, new ground rules will be proposed, because "the priority requires finishing Atucha II," even though that may mean giving up part of the local presence. Also included in this context is a "proposal for mechanisms that would enable the investors to control how the funds are spent."

2909

Intersectorial Document Demands Completion of Nuclear Plan

51002026a Buenos Aires CLARIN in Spanish
28 May 88 p 18

[Text] The various sectors associated with the nuclear industry, ranging from business owners to trade unions, and including the National Commission for Atomic Energy [CNEA], are about to sign a declaration for defense of Argentine atomic development and of "the technological autonomy achieved by the country" in this sector.

The "dossier," which will be published on Tuesday, 31 July, when the commission marks its 38th anniversary (with the backing of political figures and legislators from the Radical, Peronist, and Development movements, among other partisan groups), declares it "essential to complete the projects initiated," and demands, in particular, "abiding by the timetable for the Atucha II nuclear power plant and the heavy water plants."

Similarly, it demands that the plan for a fourth nuclear electric power plant ordered by the national government "be governed by the notion of maximum Argentinization, making possible an increased participation by Argentine technicians, scientists, workers, and business firms." It also cites the necessity for "sustained industrial development and continuity of the efforts to make full use of the industry's cumulative technological capacity and exporting potential."

The "dossier" observes: "It comes as a surprise to many Argentines that, during the very periods in which the country was submerged in a deep-seated crisis, CNEA's activity was attaining technological goals which are the legacy of but few countries that have undergone the third industrial revolution."

Then it points out that this was possible because "national interests" prevailed in the various government administrations, making feasible "an unprecedented continuity, transcending the ideological differences and political persuasions of those running the government."

It also stresses that the commission "surmounted all the difficulties of the crises, and every type of contingency, multiplying its results in the industry, and executing major projects, accepting the challenge posed by the complexity that typified them." The declaration concludes by stating that, in this process, CNEA projected itself as an "essential mainstay of technological autonomy."

The signers of this document reaffirm, among other points, "the preeminently peaceful objectives that have always guided the commission's action"; but, nevertheless, explicitly condemn "any type of arms race." They also pledge to "sustain the integrity of the institution, and to maintain the dynamic balance among the activities involving scientific research, technological development, fuel and energy production, and projects management and execution."

Negotiations

This statement, which managed to be published despite the dissent among the various signatories, relates to the arduous negotiations currently being conducted by the National Commission for Atomic Energy and the German firm KWU, to find out whether it is possible to conclude an agreement for financing the third Atucha II power plant. Yesterday, two CNEA negotiators returned from the Federal Republic of Germany without bringing any concrete results.

Nevertheless, there is said to be a certain amount of optimism in circles associated with the nuclear industry regarding the future of these negotiations; because "the German side is willing to finance as much as 50 percent of the work done by the local suppliers, through private bank loans."

2909

Low-Power Nuclear Reactor Under Development

PY0806124888 Buenos Aires TELAM in Spanish 0903 GMT 7 Jun 88

[Text] Salta, 7 Jun (TELAM)—The Applied Research Institute, INVAP, is designing a nuclear reactor that will produce 15 megawatts in low consumption nuclear plants or when the system is connected to the national electrical network.

This information was given to TELAM by INVAP Manager Tomas Buch, who attended the nuclear technology week event held in Salta on the 38th anniversary of the National Commission for Atomic Energy (CNEA).

Buch said that the project is developing well and that it should be completed in 2 to 3 years. He added that there is no reactor of this type in the world.

He also indicated that because of its capacity the reactor can be used in remote towns.

INVAP is also working on a light transportation system of self-propelled cars which run at speeds of 120 km per hour on elevated cement tracks. Buch said that the first prototype will be tested between the CNEA plant of San Carlos de Bariloche and the Pilcaniyeu plant of INVAP, both of which are in Rio Negro Province.

INVAP is also developing the technology of cobalt radition for radiotherapy with cobalt 60 for cancer treatment.

Buch said that INVAP is a state enterprise for developing technology which works both in scientific research and production. INVAP gets no subsidies from the national treasury and is self-financed. Last year INVAP had a surplus. Its budget last year was 30 million australes.

Buch said that INVAP technicians are helping to install a reactor in Algeria and another in Peru.

Province Considers Building Nuclear Plant

PY2306122188 Buenos Aires DYN in Spanish 352 GMT 22 Jun 88

[Text] San Luis, 22 Jun (DYN)—The government of San Luis Province today appointed Vice Admiral Carlos Castro Madero, retired, a former president of the National Commission for Atomic Energy (CNEA), as an advisor to study the possibility of installing a nuclear plant at one of the artificial lakes in the province.

Upon arriving here, Castro Madero revealed that his first mission will be to study the possibility of installing a low-power nuclear plant at one of the artificial lakes of San Luis.

Castro Madero said: "A nuclear plant would give the province the ability to produce its own electricity; the province currently depends on the electricity of the National Energy Interconnection System."

Castro Madero criticized the current CNEA nuclear policy. He added that the CNEA plan established during his administration "is practically paralyzed."

San Luis Province currently gets electricity from the hydroelectric plants of Rio Tercero and Dique los Molinos of Cordoba Province.

According to government plans, the electrical system of San Luis Province will be connected to the high-tension system of Chocon by a line from Realico (La Pampa) to Fortuna in southern San Luis.

Governor Rodriguez Saa promised to "use every available means to get electricity to every part of the province."

San Luis does not have enough water resources to build a hydroelectric plant.

BRAZIL

Government To Restructure Nuclebras Activities

51002027d Rio de Janeiro O GLOBO in Portuguese 3 Jun 88 p 19

[Text] Minister of Planning Joao Batista de Abreu confirmed yesterday that the government is re-evaluating its nuclear program. He revealed that there is an interministerial work group analyzing the restructuring of the Nuclebras group, with four more subsidiaries in addition to Nuclep (Nuclebras Heavy Equipment). "It doesn't make sense for a superindustry with capitalization like that of Nuclebras to be idle," said the minister.

In a document circulated privately in the economic area, it was revealed that some sectors of the government have suggested that there be a progressive privatization of Nuclemon (Nuclebras of Monazita and Associates, Ltd.), the only producer of the rare earth elements that are of strategic importance in their application in the nuclear area.

Under privatization, Nuclemon would have the technological capabilty to promote the separation and processing of derivatives from rare earths with a higher degree of purity, allowing for higher prices in the international market. Interest in participating in Nuclemon's investments has already been expressed by Japanese groups.

In April, representatives of the National Commission on Nuclear Energy (CNEN) and of Nuclemon met with directors of two Japanese groups—Santoku Metal and Nisso Iwai Corporation (NIC)—to discuss the bases for cooperation between Brazil and Japan in the production of rare earths. Under the agreement, Brazil would have access to advanced technology in the production of metals and compounds of rare earths, and would guarantee Japan's supply of these materials for the long term.

Brazil has not yet fully dominated the technology connected with the processing of rare earths. The difference in price on the international market is significant. A kilogram of concentrated itrium, with a purity level of 60 percent, costs $46.00 (CZ$7,590), while the same quantity of itrium oxide with a purity level of 99 percent is quoted in the overseas market at $100.00 (CZ$16,520).

12857

SEMA To Monitor Environmental Control of Nuclear Activities

51002027c Rio de Janeiro O GLOBO in Portuguese 9 Jun 88 p 19

[Text] Environmental control of nuclear activities finally is going to be assumed by the Special Secretary for the Environment (SEMA), according to a determination made by current legislation. Secretary-General of the Ministry of Housing, Urban Affairs and the Environment Jose Luiz Santana Carvalho, the head of SEMA, Roberto Messias Franco, and the president of the National Commission on Nuclear Energy (CNEN), Rex Nazareth Alves, met yesterday in Rio to delineate the responsibilities of each entity and to define assignments, so that existing overlaps can be eliminated.

The division of assignments is one of the recommendations of a commission comprised of scientists from the sector that has been studying the issue for the past 6 months. Other matters studied included nuclear waste and the creation of a permanent commission to be comprised of representatives from SEMA and CNEN, who will define relationships between the institutions.

Since the cesium accident in Goiania, the scientific community has complained that CNEN has taken on the authority both to develop nuclear energy and to monitor it. The law says that SEMA should be consulted on various issues, but in practice this has not happened. The accident in Goiania is a good example since, in spite of the environmental consequences, SEMA did little, and all decisions were made by CNEN. It now appears that this will change. Secretary Roberto Messias Franco said that, from now on, environmental decisions in the area of nuclear energy will have to be by consensus.

The president of CNEN said that all radioactive sources in the country have been reorganized, and that, starting on 21 June, new laboratories for radioactivity protection and measurement will be functioning in Curitiba, Belo Horizonte, Porto Alegre, Recife, Brasilia, Fortaleza, Belem and Joao Pessoa. Rex Nazareth said that, for the first time in Brazil, laboratories of this type will be totally equipped with nationally produced instruments, developed through the technology of the Parallel Nuclear Program. There are surface contamination detectors, scintillometers, and area monitors that up until now have been imported at an annual cost of dozens of millions of dollars.

12857

Uranium Exports to Japan, France under Consideration

51002027b Sao Paulo FOLHA DE SAO PAULO in Portuguese 1 Jun 88 p A-21

[Text] Brazil may begin to export uranium to countries lacking in this fuel, such as Japan and France. This possibility is being evaluated by a work group formed by

the president of the Republic through Decree No. 48 of 16 May; the group consists of the ministers of finance, mines and energy, and planning, as well as the National Security Council, which includes the National Commission on Nuclear Energy (CNEN). A decision should be made within the next 30 days, according to the nuclear fuel director of Nuclebras, David Simon, 46. He said that the group will probably opt for the immediate resumption of the final construction stage of the Angra 2 nuclear plant, and the resumption also of construction on Angra 3, both located in the town of Angra dos Reis (154 km from Rio).

The director of Nuclebras said, "The group is evaluating generally how to rescue Nuclebras from the budgetary suffocation that the state company has endured for the past 6 years." According to him, among the measures for "making the industrial aspects of the cycling of the fuel and of nucleoelectric generation, as parts of the Brazilian nuclear program, more economically viable," as called for in Decree 48, the government could opt for the privatization of Nuclemon (Nuclebras of Monazita and Associates Ltd), one of its subsidiaries in Sao Paulo. "Later, in the longer and less definite term," Simon said, Nuclep (Nuclebras Heavy Equipment), in Itaguai (73 km from Rio) should also be privatized, and Nuclen (Nuclebras Engineering) could move to the electricity sector.

Brazil has the fifth-largest uranium reserves; it has 301 tons of the raw product, which represents 8 percent of world reserves, estimated at 1.6 billion tons according to Nuclebras, which holds a monopoly on the national market. According to Nuclebras, Brazilian reserves were worth about $18.5 billion in 1984, the gross value of the concentrated product. Today a new evaluation is being made in relation to the international market.

Nuclebras says that the largest uranium reserve is in the United States, which holds 30 percent of world reserves. Next come Canada, with 17 percent, Australia, with 16 percent, and South Africa, with 10 percent. Brazilian reserves are located in the states of Minas Gerais, Ceara, Parana, Bahia, Paraiba, Para and Goias. "With all of these measures, which we really expect will be adopted, Nuclebras takes on the basic function of responding to the supply requirements for uranium to Brazilian nuclear plants," said Simon.

The president of the National Commission on Nuclear Energy (CNEN), Rex Nazareth, said through his press spokesman that he did not want to discuss the matter at this time. According to the director of Nuclebras, the work group that has been formed is executive in nature, and will provide a general orientation for expenditures, investments, and budgets for all national nuclear matters.

12857

Moreira Says Country Not Engaged in Developing Strategic Weapons

51002027a Sao Paulo O ESTADO DE SAO PAULO in Portuguese 10 Jun 88 p 6

[Text] The Minister of Aeronautics, Brig Gen Moreira Lima, said that he considered the disarmament speech before the UN by President Jose Sarney as "very good." He also said that the Brazilian Air Force was not concerned about the criticisms made in the United States, since "we do not use nuclear arms and strategies, and our military doctrine is based solely on the country's defense and the maintenance of sovereignty."

Moreira Lima denied that Brazil—holder of the title of the number-one exporter of arms to the Third World—is engaged in an arms race: "Absolutely. Our conventional arms are our entire defense. All that we have and all that we export are tactical arms, and they are not going to contribute to any disturbance of world peace. We are pursuing technological improvement, but within a defensive, not an offensive mode," he added.

In order to prove his point, the minister pointed out that this is the approach contained in the Constitution, which prohibits wars of conquest, "and that is why the country is not involved in the development of strategic arms—long range missiles and aircraft capable of carrying large quantities of bombs and arms," he said.

The minister applauded the proposal for the demilitarization of Latin America supported by President Sarney at the UN, and pointed out that the policy of arms reduction of the United States and the Soviet Union, "is greatly reassuring to the peoples of Latin America."

From this perspective, Brig Gen Moreira Lima criticized the interpretation by Reserve Vice Adm Armando Amorim Vidigal who, in a speech before the South American Peace Commission in Montevideo, warned of the presence of an existential crisis among the Brazilian military, due to the lack of potential enemies. According to the admiral—a respected strategist in the reserve since 1985—when Brazilian democratization eliminated the internal enemy, and neighboring countries, especially Argentina, became collaborators, and the possibility of an East-West war was lessened, militarism lost its reason for being.

Moreira Lima doesn't agree with this view, and describes the fact that Brazil has no potential enemies as "a boon." "It is perfect, and fits with our defensive doctrine. Instead of our worrying about preparation for war, we can direct our attention to other aspects of aeronautics: the development of civil aviation, research and development, the training of engineers, and other nonmilitary pursuits."

12857

Pocos de Caldas Mineral Processes Laboratory

81422861a Unattributed Nuclebras pamphlet in Portuguese no date pp 1-11

[Text]

Mineral Technology

Development of the technology of mineral treating processes is a step of fundamental importance in improving the economic viability of mineral projects.

For the purposes of that development, Nuclebras operates laboratory facilities in Pocos de Caldas (the Processes Laboratory) and Belo Horizonte (the Nuclear Technology Development Center). Those facilities are equipped to conduct bench and pilot tests and studies, at various levels, of the most varied mineral-metallurgical processing techniques. They employ teams of specialists with long experience in the planning and execution of experimental tests.

Mineral Processes Laboratory

This laboratory played an important role in process design, pre-operation of the plant, and the introduction of processing improvements even during the operational phase in connection with the Pocos de Caldas Plateau Mineroindustrial Complex (CIPC), and it is one of the most capable in the country as regards hydrometallurgy and uranium concentration.

Technical participation in the commissioning of the CIPC and involvement in the latter's industrial operation, along with participation in other mineral projects for the Nuclebras group and third parties, have provided the technical team at the Mineral Processes Laboratory with experience rarely available at research centers unconnected with industrial units.

Areas of activity:

1. Physical beneficiation of ores;

2. Extractive metallurgy/hydrometallurgy;

3. Chemical concentration/solvent extraction/Ion exchange;

4. Static leaching (in batteries) and bacterial leaching;

5. Chemical analyses.

Physical Beneficiation of Ores

The technology development work that results in a detailed flow chart for the physical beneficiation of a specific ore begins with preparation of the material. This involves the operations of crushing, grinding and sorting.

To carry out those operations, the Mineral Processes Laboratory has jaw crushers, roll crushers, bar grinders, ball grinders, separating screens, sorting machines and cyclones.

Physical beneficiation in the strict sense depends on the specific nature of each ore and is carried out by means of gravimetric separation (flotation), magnetic separation and electrostatic separation.

For that purpose, the Nuclebras laboratories have vibrating tables, jigs, Humphrey's spirals, flotation cells, magnetic separators and electrostatic separators. They also have a pilot flotation plant that includes systems for roughing, scavenging and cleaning, making it possible to reproduce any complete flotation flow chart in a continuous system.

Extractive Metallurgy

The leaching of mineral types in acid or alkaline solutions is a step of fundamental importance in the economy of mineral processes.

Using autoclaves for pressurized leaching and agitation tanks for leaching at atmospheric pressure, the Processes Laboratory can reproduce, in a continuous system and at various scales ranging from the bench test to the pilot stage, various leaching techniques such as curing and cocurrent and countercurrent leaching. In terms of technical resources and infrastructure, it is also capable of conducting studies of static leaching (in batteries) suitable for low-grade ores.

With respect to the process of solid-liquid separation, which rounds out the leaching operation, the laboratory has the technical capability and appropriate facilities for determining the parameters for filtration, thickening, and clarification.

Solvent Extraction

The Mineral Processes Laboratory has broad experience with this operation, which requires rigorous control for the efficient separation and purification of the various chemicals.

It has batteries of mixers-decanters at the micropilot, semipilot, and pilot levels and can reproduce the flow chart of the process in a continuous system.

Ion Exchange

In specific cases, solid resins provide a technically and economically viable alternative to organic solvents and can be used in conjunction with or in place of those solvents.

The Mineral Processes Laboratory is equipped to study that operation in stationary or nonstationary beds in connection with either clarified lyes or the pulp resin system.

Static Leaching (in Batteries)

The economical treatment of low-grade ores requires simple leaching processes with low reagent consumption. Static leaching is the most frequently used process in such cases.

The Mineral Processes Laboratory has facilities for bench- and semipilot-scale column tests as well as prepared and impermeable yards for pilot-scale leaching tests in batteries.

In addition to the conventional battery leaching techniques, the bacterial leaching technique has also been developed. In this case, proper control of the process makes it possible to create conditions for the growth of bacteria which act on sulfide minerals and generate part of the sulfuric acid needed for solubilizing those types.

The laboratory has established a bank of pure strains of bacteria of proven effectiveness on various kinds of ores.

Knowledge of bacterial action in ores is also of fundamental importance for preventing environmental pollution. By inhibiting the bacterial action naturally present in ores, it is possible to prevent contaminants from being released into the atmosphere.

Chemical Analysis

The Mineral Processes Laboratory possesses sophisticated equipment and a technical team that is skilled in conducting chemical analyses, thus assuring effective support for process development work. This also makes it possible to conduct specific tests on ore samples for Nuclebras' internal programs and for outside customers.

The available analytical techniques include:

1. Argon plasma emission spectrometry;

2. Atomic absorption spectrometry;

3. Optical emission spectrometry;

4. X-ray fluorescence spectrometry;

5. UV-VIS spectrometry;

6. Polarography, fluorometry, thermoanalysis, and potentiometry;

7. Conventional volumetric and gravimetric analysis.

Nuclebras Mineral Engineering

In addition to its activities in mineral technology, Nuclebras has brought together in its General Superintendency for Mineral Engineering a multidisciplinary technical team capable of using experimental process data to produce the conceptual and/or basic engineering design for mineroindustrial undertakings.

It also has a team specializing in conducting feasibility tests as well as monitoring and supervising the establishment of mineroindustrial undertakings.

That team's experience has been strengthened not only by its work in establishing the CIPC but also by its involvement in planning and design work for Nuclebras itself, Nuclebras-controlled firms, and outside customers.

Location

The Mineral Processes Laboratory is located on 47 hectares of land at Kilometer 13 on the Pocos de Caldas-Andrades Highway in Minas Gerais.

Its location is a strategic one, being close to the country's chief centers of demand for mineral technology services: Sao Paulo, Rio de Janeiro, and Belo Horizonte.

Address:

Brazilian Nuclear Corporations, Inc. (Nuclebras)

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Causes, Effects of Chernobyl Accident Discussed

81422861b Unattributed Nuclebras pamphlet in Portuguese no date pp 1-8

[Article originally published in KWU-REPORT in December 1986; first nine paragraphs are introductory statement by Licinio Seabra, chairman of Nuclebras]

[Text] The accident at a unit of the Chernobyl nuclear power plant had a big impact and stirred up extensive public controversy in every country involved in the peaceful use of nuclear energy. Added to that was the fact that the possibility of a disaster of exceptional seriousness—only a theory until then—had been confirmed by the reality of the accident and its implications.

To place the Chernobyl accident in its proper context, we should remember first of all that the use of nuclear energy to produce electricity is now a worldwide reality: there are 396 nuclear power plants in operation in about 30 countries. Nuclear energy generates from 40 to 70 percent of all the electric energy produced in such countries as France, Finland, Switzerland, Belgium, and Sweden.

The tremendous concern following the Chernobyl accident caused the IAEA, an agency of the United Nations, to call an international conference to hear the report on what had happened from Soviet scientists directly and to analyze the implications. Brazil was represented by a Nuclebras scientist at that conference and in the preparation of the official IAEA report.

Following the international community's thorough analysis at the Vienna Conference on Chernobyl, the IAEA concluded that "nuclear energy, in its current state, is an acceptable and beneficial source of energy" ("Official Report of the IAEA on the Chernobyl Accident," No 75-INSAG-1, 1986, page 81).

But what really happened in Chernobyl? That is what the article we are reproducing below explains in detail. It was published originally in the December 1986 issue of KWU-REPORT, a magazine published by the West German firm of Kraftwerk Union (KWU), which is Nuclebras' partner in implementing the Brazil-FRG Nuclear Agreement.

The article shows that an extraordinary combination of deliberate violations of a series of safety regulations—including the willful disconnection of several protection and safety systems—had the effect of causing the reactor to operate under conditions for which it was not designed. Under those conditions, it was a feature of the design specific to that Russian reactor which led to an uncontrolled and extremely fast build up of power, causing the steam within it to explode. Since the reactor building had no containment barrier, large quantities of radioactive material were expelled into the atmosphere. The cause, therefore, was a combination of serious human errors and specific design characteristics.

An accident of that kind cannot occur in a pressurized light water reactor, which is the type that predominates in the West, including Brazil. This was proven by the accident at Three Mile Island in the United States in 1979, in which serious human errors caused a partial meltdown of the reactor core with a release of radioactive products. But practically all of those products were contained within the reactor containment vessel. As a result, the effects on the population were insignificant.

We, therefore, have confidence in the units at the Angra Nuclear Power Plant because of their superior safety characteristics in comparison with Chernobyl and, above all, the fact that they have a containment vessel, which was nonexistent at the Soviet power plant.

These questions were analyzed throughout the world, and the conclusion reached was that there was no reason to interrupt any nuclear programs. In 1986 alone, 23 new nuclear power plants in 9 countries were licensed to go into operation.

In no country in the world has the reactor disaster in Chernobyl aroused more widespread and violent controversy over the use of nuclear energy for peaceful purposes than in the FRG. There are several reasons for this. The decision by the Social Democratic Party [SPD]—the majority national party—to abandon nuclear energy once and for all seemed even more justified in view of the disaster that had occurred, seeing that the possibility of an exceptional degree of danger, which had been purely theoretical in the past, appeared to have been confirmed in a very impressive manner by the reality of the accident and its implications. The Green Party's success at the ballot box reflects the reasoning of that movement, which is dogmatically committed to the rejection of nuclear energy. With the elections approaching, those two parties—the SPD and the Green Party—tried to exploit Chernobyl and gain as much political advantage from it as possible. Those efforts were related to the strong feeling of insecurity being experienced by the population as a consequence of the manner in which the authorities, experts in various branches of science and so-called critical scientists reacted to radioactive fallout in the FRG's territory.

Who was right? Who was trying to conceal the real situation? Who was exaggerating? In short, whom should one believe? Perplexity and anxiety invaded even the special supplements of respected newspapers. In those circumstances, it was inevitable that the many media would be unable to resist the temptation to stir up even more hysteria in a substantial portion of the population with their biased reporting instead of using moderation and calmness to try to control those emotions. The effect on the growing uneasiness was similar to that of a loudspeaker. Considering the tendency of Germans to overmobilize emotionally and to fearlessly give their obstinate support to movements they consider fundamental and correct without ever surrendering to reason, the alarm level finds its explanation. And one begins to understand that paradoxical situation in which the nation with the strictest safety regulations in the world for preventing serious nuclear accidents is also the country in which the most vehement calls to abandon nuclear energy have been made since Chernobyl.

Moreover, the experts chose to react very moderately and hesitantly to the disaster at the Russian reactor. Although it was clear from the start that an accident of that kind could never have occurred in the FRG because of the differences in reactor design and safety measures, the specialists abstained in good faith from making any comment until they were in a position to present more balanced judgments based on more detailed information, since all they had to go on was fragmentary knowledge of the sequence of events. In those circumstances,

any hasty comments might certainly have been interpreted as being intended to calm people down or allay their fears. The result, then, was that opponents of the nuclear energy program were allowed to do all the talking. And while that stalling for time was going on, it was obviously necessary to live with the fact that both the supporters and the opponents of nuclear energy would have the impression for some time that the experts were embarrassingly confused and profoundly shaken.

Since that time, much has been said and written about Chernobyl by people both qualified and unqualified. Scarcely a day passes without some mention in the media of that Ukrainian nuclear power plant, which was once known only to specialists. That is the way things have stood for several months. It shows the extent to which this "plague" afflicting the nuclear industry is affecting public opinion and also demonstrates the unflagging interest being exhibited by journalists. The situation will probably not change in the near future, meaning that the nuclear industry will have to learn to live with the problem.

Now, with the first signs that the nervousness is fading, it is becoming clear that the thoughtless abandonment of nuclear energy in the FRG would not be an easy or intelligent step to take. If forced on us, it would bring big economic, social, ecological and technological disadvantages for the entire country. The answer to the question of how long a period would be needed before it would be possible to abandon nuclear energy in the medium term depends largely on how quickly nuclear energy could be replaced by equivalent sources guaranteeing a long-term economical and independent energy supply. The answer to that question must come from the leading supporters of abandonment of that source of energy—that is, the SPD and, more recently, the unions.

Nuclear energy's supporters are now convinced that nuclear energy is not going to be abandoned internationally and that the FRG would have to expect a number of disadvantages if it decided to adopt an isolated attitude. If we consider the growing energy demand due to the population explosion in Third-World countries and the finite nature of the world's energy reserves, we see that only nuclear energy offers the prospect of adequate energy supplies likely to last for the next few centuries. It is therefore urgent to remind West German public opinion that the FRG possesses a high-quality source of energy in the form of nuclear power that should not be frivolously sacrificed in response to opportunistic maneuvering. That same public opinion must also be assured that our country need not fear an accident involving a core meltdown. At this point, we need to examine that last-named problem more closely.

What Happened in Chernobyl?

Seeing that the chief characteristics of the Soviet RBMK reactor have already been described on innumerable occasions, we will simply present a brief summary of the causes of the accident and of the sequence of events in order to focus primarily on the most important differences between that model and the light water reactors operating in the FRG.

According to the explanation provided by Soviet authorities, tests were being conducted to determine whether it would be possible, while operating with emergency power, to use the reduced power of the turbine to generate energy through the electric generator until the diesel units were in a position to supply sufficient energy. Providing that backup for the startup phase of the diesel units by gradually shutting down the turbine is one of the safety measures developed for nuclear power plants of the Chernobyl type. Similar tests had already been conducted, but their results had not been completely satisfactory. As a result, the generator control system had been modified and was to be tested as part of the experiment that was underway.

The plan called for conducting the experiment at approximately one-third of the reactor's total power. But an operator error caused the reactor to be disconnected as it was being switched to its lowest power level. Starting over would have been difficult because neutron-absorbing xenon was building up in the reactor, and the result was that the absorbing rods and control rods were withdrawn completely from the reactor core and the surrounding graphite reflector. Such a condition makes rapid disconnection impossible in that Soviet type of reactor because there is no way to reinsert the absorbing rods quickly enough when necessary. In fact, according to the power plant's operating standards, the reactor should not even be operating in that manner.

Nevertheless, the experiment was begun by shutting the turbine's steam intake valves. Normally, the reactor should have disconnected itself automatically at that moment. But the various automatic safety devices had been deactivated (just as other safety engineering features had been deactivated previously) by the operating personnel because they wanted to keep the reactor in operating condition for a possible repetition of the experiment. Those choices caused a condition in which the reactor continued to produce energy that could not be removed by the generated steam. This meant that the generated power had to be stored—in other words, the fuel and the moderator heated up.

According to the Soviet report, responsibility for the experiment had been entrusted to an electrical engineer who was very familiar with the generator control system but knew little about the dynamics of reactors. For its part, the operating crew was obviously not sufficiently familiar with the reactor's responses at low power levels, the reason being that the reactor was usually operated at full power.

The result was that the events of 26 April took a dramatic turn: The generated power could not be dissipated, and the result was a buildup in the volume of

voids in the coolant. Additionally, the reduced discharge through the pump caused a drop in volumetric flow (flow rate) and, in turn, a further increase in steam generation. That resulted in less neutron absorption by the water, along with an increase in the effect of the graphite moderator on the chain reaction (positive void coefficient). The reactor's power increased abruptly (power excursion). After about 40 seconds, manual disconnection of the reactor began, but it was too slow. According to Soviet calculations, generated power exceeded the nominal rating by over 100 times. The fuel melted and evaporated, at least in part of the reactor—in the cladding tubes. Apparently, some of the cooling channels suffered irreparable damage as a consequence of the high steam pressure produced.

It is possible that the first explosion occurred at that point. In any case, a chemical reaction was triggered between the water and zirconium in the fuel cladding tubes and cooling channels, and that released highly explosive hydrogen and heat. There is mention of two explosions within a few seconds of each other, although the exact mechanics and chronological sequence are not very clear. There may have been a hydrogen explosion in both occurrences, although the first may have been an explosion of water steam during the violent disintegration of the fuel, which came in contact with the coolant in a finely dispersed form. The energy that was released caused irreparable damage, with the well-known tragic consequences, to the radiation shielding on the top of the reactor, all the cooling channels, and the top part of the reactor building (which, unlike West German installations, lacked containment). From 6 to 8 metric tons of uranium from the reactor were discharged inside the destroyed building and in its immediate vicinity. In addition, there was contact between the air and the hot graphite, about 10 percent of which (250 metric tons) caught fire.

The analysis conducted later did not reveal whether significant quantities of fuel had melted subsequent to the explosions. During the first few days after the accident began, it was feared that the reactor core would melt and penetrate its foundations. For that reason, a tunnel was excavated beneath the reactor building to permit the insertion of a slab of concrete and cooling facilities. That measure was adopted to prevent the contamination of groundwater. All the barriers designed to prevent radioactive discharges had been destroyed by the explosions, and gaseous substances had leaked out completely. In the days that followed, the reactor was covered with sand, lead, and boron (which absorbs neutrons) in an attempt to prevent new discharges of radioactivity. After an interval of 8 days, more radioactivity leaked out, probably because it had been impossible to remove residual heat through the shielding and the reactor core had heated up again.

Were the Errors Only Operating Errors?

The basic statements in the explanations provided by the USSR Government Commission set up to investigate the events that occurred during the accident and their sequence were as follows:

1. The main justification for the operating personnel's behavior was their intention to carry out the tests in the shortest time possible.

2. Failure to comply with instructions for preparing and conducting the tests, the departures from the test program, and negligence in operating the reactor make it evident that the personnel were unfamiliar with the special characteristics and processes inherent in a reactor and that they had lost all notion of the implicit dangers.

3. Safety precautions had not been taken during the design phase to prevent an irregularity or accident resulting from a combination of the circumstances that prevailed in this instance—that is, the deliberate disconnection of safety systems in combination with violations of the plant's operating standards.

4. The chief cause of the accident was a highly improbable combination of failures to comply with the instructions and requirements related to operation of the plant.

5. The accident took on catastrophic proportions because the operating personnel placed the reactor in a condition of prohibited relationships in which the positive void coefficient of reactivity was able to increase the power excursion substantially.

The summarized assessment of the accident and its sequence by the USSR Government Commission is basically acceptable except for one item: the various violations of operating standards and of the instructions referring to the experiment were all committed for the purpose of facilitating the work related to that experiment and its possible repetitions. Consequently, the combination of those violations was not "extremely improbable." That makes clear the importance of the safeguards built into West German nuclear power plants when it comes to preventing interference with the safety engineering features. Those features are the constant object of painstaking tests, including tests stemming from the accident in Harrisburg.

Safety Features With Provision for Error

The effectiveness of a containment was proven in Harrisburg (Three Mile Island), where safety design errors and errors committed by operators led to an accident in which the reactor was no longer being cooled properly. The fuel elements melted, and there was a hydrogen explosion inside the containment. The result was a major release of fission products similar to that caused by the accident in Chernobyl except that the fission products

remained inside the containment. The environment suffered practically no damage at all in comparison with Chernobyl: No more than from 0.1 to 1 percent of the radioactive inert gases and a few fractions of a percentage point of the other radioactive substances ejected from the core penetrated Harrisburg's atmosphere.

Pressure-proof containment is one of the four passive safety barriers used to combat the release of radioactivity in light water reactors of the type operated in the Western World. The first of those barriers is the nuclear fuel structure itself, which retains a large portion of the fission products. Next come the impervious fuel cladding tubes. The third is the reactor's steel pressure vessel with its primary circuit tubing, and the fourth is the containment vessel, also made of steel, which encloses the entire reactor system in pressurized water versions and the nuclear steam-generating system in boiling water reactors.

The safety concept was designed to ensure that the barriers would operate even in case of an accident. Experience shows that even with the greatest care in the world, there is no way to operate technical equipment with no malfunctions. In general, any safety strategy aimed exclusively at preventing malfunctions would be doomed to failure from the start. It is obvious that the sources of potential errors and accidents must be systematically eliminated, but another crucial factor is that a system is reliable only when it is capable of dealing with errors and defects. That being the case, the KWU systems developed and designed for nuclear power plants allow for the possible occurrence of technical malfunctions and operator errors despite highly complex quality control and operator training programs and ensure that any such malfunctions or errors will not render the overall safety systems inoperative.

That concept of safety with provision for error has proven to be very successful. So far, West German nuclear reactors have not suffered any irregularities or accidents in which the reactor reached the first stage of overheating. It has even been proven that the Three Mile Island accident could never have occurred in a West German power plant because all the decisions rendered necessary by a malfunction are made by the completely automatic safety system—which takes control of the reactor for the first 30 minutes following the start of an event. During that critical phase, therefore, the sequence of events will not depend on the reactions of the operators, who may be under great stress. As a result, the importance assigned to human shortcomings as constituting a danger to nuclear power plants has been considerably reduced.

Error Control With Rapid Disconnection of Reactor

Two preponderant factors caused the Chernobyl accident to turn into a disaster: the reactor's inherent lack of stability (positive void coefficient) and the fact that it had no containment. Those two negative factors do not exist in the FRG's light water reactors, since all are inherently stable and are fitted with pressure-proof containment. Their negative void coefficient guarantees the automatic interruption of chain reactions if the moderator should happen to form more voids as the result of an accident. The control rods would not even be needed for a disconnection of this type.

The Chernobyl accident (involving an uncontrolled increase in generated power with no emergency disconnection of the reactor) is one of the design accidents allowed for in West German nuclear power plants. For that reason, the licensing procedure for a reactor requires proof that an accident of that type can be completely controlled. That anticipated transient without rapid disconnection of the reactor (known as ATWS: anticipated transient without scram) is not even a problem at that point because of the inherent self-stabilization designed into West Germany's reactors. As a result, the possibility of a nuclear power plant accident affecting the environment could be ruled out even if the operators were to commit the same errors as their colleagues in Chernobyl.

Even a Maximum Credible Superaccident Would not Be a Disaster

For approximately 16 years, scientists have been involved in work related to the risks inherent in an accident involving a core meltdown in light water reactors. An accident of that kind could occur if a nuclear power plant's safety systems failed completely during a serious accident involving the loss of coolant (known as a maximum credible accident, or MCA) in which the fuel elements remained without coolant for a long period and the decay heat were not removed from the reactor. It is very probable that the gradual result would be a melt mass reaching a temperature of about 2,000 degrees Celsius and slowly melting into the reactor building's concrete foundations after penetrating the pressure vessel. The expression "maximum credible superaccident" is usually employed to to describe an accident involving a core meltdown.

Although the safety features with provision for error eliminate practically all possibility of an accident involving a core meltdown, the potential causes, sequence of events, repercussions, and probabilities have been the object of painstaking research.

Thoroughgoing analyses conducted in the United States (the Rasmussen Report) have been adopted by the Karlsruhe Nuclear Research Center (KFk), the Reactor Safety Company (GRS), and other organizations, adapted to meet the conditions existing in the FRG (a higher population density and stricter safety standards), and actively refined on the basis of tests. The work has focused on a nuclear power plant of the Biblis type with a presssurized water reactor (comparable risk analyses covering boiling water reactors were available in the United States and Sweden). With the passing of time and the growing intensity of the work being done by scientists

on the subject of core meltdowns, it became increasingly clear that the potential consequences had been considerably overestimated in older basic research (German Risk Study). As a result, it is now possible to single out one conclusion that is no longer subject to doubt: Containment would effectively protect the environment from effects having a great impact.

During a core meltdown, the containment's interior would be exposed to a gradual buildup of pressure owing to the release of gases and the steady evaporation of water in the building's well.

Although it would certainly take the pressure a minimum of 5 days to cause a leak in the containment, the high initial concentration of fission products thrown off by the melted mass would have decreased to such a point by then that only small quantities could escape through the opening in the containment. But that interval of 5 days would give the operating personnel the necessary time in which to initiate selective countermeasures such as deceleration or even the prevention of leaks from the containment by taking steps to bring about a slight alleviation of pressure. That being the case, a situation of maximum credible overheating in a West German nuclear power plant—highly improbable in itself—would not have disastrous effects on the environment.

Consequently, denying that an accident as extensive as that in Chernobyl could occur in the FRG is not a trick or a lie, nor does it reflect blind faith in technology.

As far as the use of nuclear energy for peaceful purposes is concerned, Chernobyl was a calamity and a scourge that will mark such use for many years to come. It also caused concern among the supporters of nuclear energy and has probably had a salutary effect by increasing international willingness to begin mutual consultations and undertake efforts to come up with improved safety. (The Soviet Union showed clearly in Vienna that it was prepared to install safety equipment in its RBMK reactors.) All the same, it was only the violent public controversy that made many West German citizens aware of the real value of nuclear energy in terms of their country's economic, social and ecological future. There are highly encouraging signs that people are growing calmer as the disaster at the Chernobyl reactor recedes into the past, the exception being the politically motivated calls to suspend nuclear energy and change direction. In any case, Dr Karl Heinz Beckurts, then a member of the KWU's board of directors, was correct when he wrote the following in an article that was published in DIE ZEIT on 18 July 1986, after his assassination by a terrorist group: "From the standpoint of safety, the use of nuclear energy in Germany is no less justified today than it was before 26 April 1986."

Note: In May 1987, NUCLEN [Nuclebras Engineering, Inc.] and the CNEN [National Nuclear Energy Commission] sponsored an international seminar on the topic "Severe Accidents in Light Water Reactors." That seminar, conducted by the IAEA, included the participation of eminent international scientists who had taken part in evaluating the Soviet report on Chernobyl. Brazilian participants in addition to the CNEN and NUCLEN were Furnas, the COPPE [Coordination Board of Postgraduate Engineering Programs], and the CDTN [Nuclear Technology Development Center].

Illustration Captions

1. This photo of the destroyed reactor building at Unit 4 of the Chernobyl nuclear power plant is a document for posterity in the history of the use of nuclear energy for peaceful purposes. After accumulating a total of 4,000 years of reactor operation, nuclear energy has claimed its first victims. They died because of incredible carelessness on the part of plant operating personnel who, by reason of an inadequate safety system, were able to deactivate practically all the engineering safety equipment while conducting experiments. This photograph will, however, also preserve the memory of heroic action by the Soviet firemen who lost their lives fighting the fire.

2. Soviet RBMK reactors are graphite moderated and water cooled. As is possible and normal in boiling water reactors, the steam passes first through steam separators and is then sent directly to the turbine (Chernobyl has two separate 500-mW turbines). The combination of graphite as moderator and water as coolant causes problems because of the positive void coefficient. If the coolant were to evaporate for any reason (an event which would automatically interrupt the chain reaction in a light water reactor), the chain reaction in this type of reactor would not only continue but also increase.

3. Unlike the system used in the pressure vessels of other reactors, fuel elements in the RBMK reactor are housed in individual pressure tubes and are subject to relatively frequent rehandling and replacement by a refueling machine while the reactor is in operation. This is the only way to achieve an optimum distribution of power in the core and a maximum irradiation rate.

4. Measurements being taken of the chessboard-type shielding on the RBMK reactor, which is reloaded with no need to interrupt power plant operation. The individual tubes holding the fuel elements, absorbing rods, and instrumentation inside the core are located under marked covers that must be removed only by the refueling machine.

5. A West German nuclear power plant has four barriers for preventing the release of radioactivity; the nuclear fuel structure, fuel cladding tubes, the reactor pressure vessel with tubing, and the steel containment.

6. The active safety systems in West German nuclear power plants (the drawing above shows the systems used in a pressurized water reactor) were designed with

"redundancies" and are distinguished by their operational diversity—that is, their operating methods are different. They are checked at regular intervals to ensure that they are operational. A substantial loss of coolant ("maximum credible accident") would automatically start the core's emergency cooling system, which comprises, in addition to the emergency diesel generator, four parallel sets that are completely independent of each other, only two of which would be enough to limit the size of the accident. A maximum credible accident would have no significant effect on the environment.

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INDIA

Spokesman Assails Pakistani 'False Propaganda'

BK2406161388 Delhi Domestic Service in English 1530 GMT 24 Jun 88

[Text] India dismissed as baseless, motivated and mischievous a Pakistan Radio broadcast about the possibility of Indo-Israeli collusion to attack Pakistan's nuclear facilities. Reacting to the broadcast, a spokesman of the External Affairs Ministry said the Pakistan media has been in the habit of spreading baseless allegations on this and other questions.

The spokesman recalled that the government recently denied reports suggesting that India is upgrading its ties with Israel. He charged Islamabad with indulging in spreading false propaganda against India while Pakistan itself is furiously engaged in pursuing nuclear weapons-oriented program.

Problems Plague India's First Fast Breeder Reactor

51500181 Bombay THE TIMES OF INDIA in English 14 May 88 p 9

[Text] The teething troubles of India's first fast breeder test reactor (FBTR) that attained criticality in 1985, are far from over and it is still not working.

The problems encountered by Indian experts in mastering this technology have provided valuable experience with regard to the functioning of the reactor vessel and the sodium pump which helps in cooling the system. The reactor which is undergoing major repairs, may be restarted "soon," according to the annual report of the atomic energy department.

The immensity of the technological challenge in this which holds the promise of unlimited power from limited fuel, can be gauged from the fact that it was in 1971 that a large research centre was set up at Kalpakkam to spearhead research in the development of sodium-cooled fast breeder reactors.

The 13 MWs FBTR was built and fuelled by an indigenously developed uranium-plutonium carbide. However, power operation was delayed due to difficulties experienced during the transfer of fuel sub-assembly. The nitrogen plant, preheating and emergency cooling circuits had to be improved. One of the secondary sodium pumps had to be replaced due to noise observed on the discharge line.

The reactor was made critical in April 1987 after several allied works had been completed. However, problems cropped up during the transfer of a fuel subassembly to a peripheral location in the reactor. Because of the large-scale damage, it became necessary to replace the guide tube along with the subassemblies. A new guide tube and fuel handling gripper subassembly are being manufactured at the centre itself.

According to the report, the design of a pool type prototype fast breeder reaction of 500-MWs capacity is progressing well.

With regard to the Narora power plant, the report says that the first unit is expected to achieve criticality in October this year. The project has been delayed mainly due to the late delivery of steam generators.

The two units of the Karapar atomic power project will attain criticality in 1990 and 1991 respectively. The two units of the Kaiga atomic power project and two of the new Rajasthan project will be commissioned in 1995.

The detailed project reports for setting up two 500-MW units of pressurized heavy water reactors are being considered by the government. The work of six such units is proposed to be started during the seventh plan.

In the area of safety and damage control, the department has formed a crisis management group to deal with all emergency situations that may arise due to an accident at a nuclear establishment. An emergency control room has been set up at the department headquarters for establishing a communication link with various nuclear power stations and heavy water projects.

For reliable communication, the department will have its own transmission network consisting of seven satellite earth stations that will be installed by March 1990.

The group will report to the national crisis management committee, headed by the cabinet secretary in New Delhi, regarding developments in an emergency.

A draft action plan for an emergency during transport of radioactive consignments has already been prepared and presented to an inter-ministerial committee.

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Safety Committee Reports on Tarapur Atomic Plant

BK2306082083 Delhi Domestic Service in English 0730 GMT 23 Jun 88

[Text] The committee set up to review the safety of the Tarapur atomic plant has found that the working conditions at the plant are adequate to permit continued operation. There has been a continuous improvement in the control over radiation exposure at the atomic station and the release of radioactive effluents to the environment has been kept well below the authorized limits.

Tuticorin Heavy Water Plant Deemed Costly, Slow
51500183 Bombay THE TIMES OF INDIA in English 16 May 88 p 4

[Text] The report of the comptroller and auditor-general (CAG) has criticised the department of atomic energy (DAE) for cost overruns, delays and below target production levels at the Tuticorin heavy water plant, India's largest source of indigenous heavy water.

The CAG report for scientific departments, released separately for the first time, says the production performance of the plant has been "far below the anticipated levels" while the total project investment has more than doubled."

Heavy water is a crucial component of the country's nuclear power programme aimed at generating 10,000 MW of power from the atom by 2000 AD through a chain of uranium fuelled reactors which use heavy water as moderator and coolant.

The Tuticorin plant, which has produced 60 percent of indigenous heavy water, has had an average annual production of only 20 percent of the installed capacity. And the plant has operated only 1,284 days instead of an available 2,550 days in the last eight years, the report said.

The cost of the heavy water itself has gone up from a DAE estimate of Rs 4,120 per kg to more than Rs 13,800, a figure based on the actual average annual production.

According to the report, the total capital cost went up to Rs 4,893 lakhs, a 130 percent increase over the original projected cost of Rs 2,761 lakhs.

The shortfall in production has amounted to Rs 186.67 crores, the report said.

The report said the plant took seven years to build despite the construction time for heavy water plants initially planned to be four to five years.

The delays have been attributed to extra time spent on the completion of structural works,erection of the plant and on fabrication of the equipment.

In a section on the indigenous research sector "Dhruva," the CAG report said the reactor has not functioned at the designed power levels so far while the production of radio-isotopes, a key objective of the reactor, has been delayed.

The Dhruva project took 99 months to complete instead of the projected 55 months and the total expenditure went up, the report said.

The radiation facility for the production of the radio-isotope iodine-125 and some basic research facilities had not been established at Dhruva till October 1987, the report said.

The CAG report has charged the department of space of losing five years and investing Rs 65 lakhs without any benefits because it tried to productionise a product without complete technology.

The product which the report has coded "X", an important component of the polar satellite launch vehicle (PSLV) programmes, was initially developed in the laboratory at the Vikram Sarabhai Space Centre.

To save time the Indian Space Research Organisation (ISRO) skipped the pilot plant stage of the process and tried to convert into an industrial product. This led to snags during attempts to scale up the technology, the report said.

Finally, ISRO had to import product "X" to ensure that the PSLV programme went ahead uninterrupted.

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Indigenous Robots Working in Nuclear Units
51500184 New Delhi PATRIOT in English 14 May 88 p 2

[Text] Robots, developed by Indian scientists, are now used for checking leaks in pipes of nuclear reactors and helping conduct routine functions in deadly nuclear environment, reports PTI.

They are being used in several nuclear installations to fabricate and reprocess nuclear fuel and in the inspection of pipes of nuclear reactors, says the annual report of the Department of Atomic Energy for the year 1987-88.

The report says various remote handling systems and prototypes of mobile and non-mobile robots are being designed, fabricated and installed for use in nuclear installations.

The report says the "pick and place" robot, developed by scientists of the Bhabha Atomic Research Centre, has been deployed in several installations such as in nuclear fuel complex and in the Trombay fuel reprocessing plant. The multiple gripper of the robot can handle four fuel pellets at a time.

An articulated robot with four degrees of freedom has been developed for handling fuel pellets. The robot picks up pellets from the conveyor system and places them sequentially in sintering trays.

The report says a robotic system capable of automatically handling liquid samples for radioactivity determination is being developed and it will be ready by the end of this year.

These robotic systems will be installed at the fuel reprocessing facilities at the Bhabha Atomic Research Centre and Kalpakkam atomic plant. A personal computer will be able to control several such robots, says the report.

The report says a robot, which has four probes for inspection of pipes in rectors, has been developed and tested.

A six-legged walking robot capable of adopting different gaits and orientations, with a total of 18 degrees of freedom has been developed. It is expected to carry out diverse tasks in highly radioactive areas and can be provided with protective clothing for easy decontamination and prolonged life.

A robot that can be used to handle and manipulate objects weighing up to five kilograms, and can perform tasks widely varying in speed and accuracy such as welding, material handling, also been developed by scientists of the Bhabha Atomic Research Centre, the report adds.

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Rich Uranium Deposits in Andhra Pradesh, Other Areas

51500186 Madras THE HINDU in English
5 May 88 p 6

[Text] Rich deposits of uranium have been found in Rayalaseema district of Andhra Pradesh as well as in Madhya Pradesh and Meghalaya. The Minister of State for Science and Technology, Mr. K. R. Narayanan, told the Lok Sabha during question hour today. The exact amount of deposits is not yet known.

Following an experimental aerial survey, a number of promising sites for uranium deposits, have been identified also in parts of Cuddapah district of Andhra.

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Audit Agency Report Puts Heavy Water Claims in Doubt

Details of Report

51500196 New Delhi PATRIOT in English
18 May 88 p 5

[Text] Official claims about self sufficiency in heavy water have been shattered by the report of the Comptroller and Auditor General (CAG) released recently, reports PTI.

The report leads to an inference that indigenous heavy water production between 1978 and 1986 was about 190 tonnes, far short of the 600 tonnes required for commissioning the two power reactors of Madras and the Dhruva research reactor in Trombay.

The two Madras reactors required 250 tonnes each initially and 15 tonnes annually, while the Dhruva reactor required 78 tonnes. All the three reactors were commissioned between 1983 and 1985.

The publication of the CAG report almost coincided with international press reports alleging that the 15 tonnes of heavy water found missing in a Norwegian plant had been diverted to India.

India had officially denied this, but the CAG report on the performance of heavy water had given new ammunition to those accusing India of receiving shipments of heavy water illegally.

The audit report has not disclosed annual production figures in keeping with the policy of the Department of Atomic Energy (DAE) but has given an idea about the cumulative production through a cryptic statement.

The report said the Tuticorin heavy water plant is the most successful among all operating plants having produced 60 per cent of the indigenous heavy water although its average annual production between 1978 and 1986 has been only 20 per cent of the rated capacity.

Given the fact the rated capacity was 71 tonnes, the total production of Tuticorin plant for eight years worked out to be 114 tonnes. Considering that this represented 60 per cent of the national heavy water output the total indigenous production, according to the report, was about 190 tonnes.

The audit report, placed before Parliament in the last week of the budget session had thus made it evident that India was short of indigenous heavy water at the time it commissioned Madras atomic power station.

American reports two years ago that India made up the shortage by importing it from China and ciphonning it off from the disused Rajasthan atomic station had been denied by the Government.

The DAE regularly published heavy water production figures until 1982, but this information was classified shortly after the commissioning of the first unit of the Madras atomic station in July 1983.

The Soviet Union had officially stated that it had so far supplied 450 tonnes of heavy water to India. This, according to DAE has been used in Rajasthan reactors which were under international safeguard.

All other unsafeguarded reactors under operation or under construction depended on indigenous source of heavy water.

Program May Not Be Achieved

51500196 Calcutta THE SUNDAY STATESMAN in English 22 May 88 p 6

[Editorial]

[Text] Despite the assertion by the Union Minister of State for Science and Technology, Mr K. R. Narayanan, that "we don't go on stealing," the controversy over allegations that in 1983 India secretly obtained 15 tonnes of Norwegian heavy water may be revived by the Comptroller and Auditor-General's latest report which has presented a rather gloomy picture about the country's heavy water output. Suspicions will probably be further strengthened by the fact that instead of disclosing the annual production figures of the heavy water plants, the Atomic Energy Department has given what may be described as a cumulative production pattern. Even then, it has not been able to gloss over the uncomfortable fact that production between 1978 and 1986 was a mere 190 tonnes, considerably less than the 600 tonnes required for commissioning the two nuclear reactors in Madras and the one at the Dhruba research center in Trombay. This is not, of course, the first time that official disclaimers have been treated with scepticism. Although the position may have improved since 1982 when the Minister of State for Atomic Energy told Parliament that there was a "tremendous shortage" of heavy water, there is little doubt that production has generally lagged a long way behind schedule. As the Comptroller and Auditor-General's report has pointed out, the Tuticorin plant, which is supposed to be more successful than the others, worked at only 20 per cent of its capacity between 1978 and 1986. Since even this capacity was earlier "reassessed" at 45 tonnes compared to the original 71 tonnes, the output may have been lower than the 114 tonnes estimated in the eight-year period.

But if the Tuticorin plant has somehow been limping along, especially after it broke down on several occasions and special safety devices had to be developed, the one at Talcher seems to have set a record of sorts for, according to the report, it "failed to produce even a drop of water almost 12 years after its erection and two and a half years after it was declared mechanically complete." Nor is this very surprising because the plant is said to be based on a process which was developed only up to the laboratory stage in Germany, and there is apparently no similar plant anywhere in the world. The Tuticorin plant, as well as the one in Baroda, is also unique because they are said to be based on a process not in use anywhere except in a plant under construction in Argentina. All this is likely to reinforce earlier misgivings about the Atomic Energy Department's inordinately ambitious plan of achieving a power output of 10,000 MW by the turn of the century. To sustain such a high output, a heavy water production capacity of about 13,000 tonnes will have to be built up. Arguably, the existing plants, as well as the two under construction in Manuguru and Hazira with capacities ranging from 130 to 200 tonnes, may be able to meet the demand if they run well, and if more plants are planned. But going by present indications, such a possibility seems extremely remote.

Credibility Damaged

51500196 New Delhi PATRIOT in English 23 May 88 p 4

[Editorial]

[Text] The recent heavy water controversy, triggered by Western allegations that India clandestinely procured 15.18 tonnes of the precious commodity from Norwegian sources through a West German firm in 1983 to help the commissioning of the new Madras Atomic Power Plant-I, has once again brought into sharp focus the nuclear realities in the subcontinent. Apart from depreciating India's totally indigenous efforts to develop her nuclear power production capacity, the allegations betray an attempt to equate India and Pakistan on the nuclear issue by making out that India too has been securing by clandestine means nuclear material to sustain her programme. Though no evidence has been adduced, Pakistan, understandably, has lost no time to derive a propaganda advantage from the charges and debunk India's independent, peaceful development programme in the nuclear field. All evidence shows, though, that it is Pakistan, which has no heavy water production capacity, must depend on such "procurement" from abroad to run such atomic installations as the Karachi power unit or the secret Kahuta plant.

The recent allegations, however flimsy, as those in the past, stem from Western powers' ire at India's steadfast refusal to accept the nuclear non-proliferation treaty which, New Delhi has maintained, is discriminatory, and would subject her facilities to international inspections, mainly, from West-dominated "London Club". Prima facie, as named and unnamed Carnegie Endowment and U.S. officials have rushed to say, what has lent "strength" to suspicions against India is the circumstantial fact that the country's indigenous heavy water production from the half a dozen plants fell to critically low levels five years ago. The shortfalls, in fact, held up the commissioning of the MAPP-I unit at Kalpakkam, which had largely been ready to go on the stream by 1980. Even so, as Department of Atomic Energy officials have pointed out, the shortfalls that year were of 250 tonnes of heavy water and such paltry shipment as 15 tonnes from Norway, which international investigators, incidentally, say is still "missing", could not be enough for meeting the needs of MAPP-I. The plant was commissioned on 27 January 1984, with built-up reserves of heavy water from other units and establishments in the country, and its dedication ceremony in December 1986 was attended by Pakistan Atomic Energy Commission officials.

While there may be some merit in an official spokesman's dismissal of the charges as "motivated stories: and in Prime Minister Rajiv Gandhi's assertion that the country "has enough heavy water of its own and no need to buy from outside", a woeful mismanagement, callous neglect of priorities, administrative indifference and sheer accidents which have plagued the country's heavy water production programme cannot be easily brushed aside. These as well as the unkept construction schedules and delays in the commissioning of new plants appear to have caused a serious set back to the country's plans to build up annual production capacities of 13,000 tonnes of heavy water by 1999. The huge quantities would be required if schedules for 10,000 MW nuclear power generation by 2000 AD are to be met. It is an ill-concealed secret that the six heavy water plants at Nangal, Baroda, Kota, Tuticorin, Talcher and Thal have never run to full capacity levels of a total 550 tonnes and that the country had to rely on Soviet supplies to keep the atomic-power stations going. The stinging criticism the Comptroller and Auditor-General has made in his report on the cost overruns, delays and below-capacity production levels at Tuticorin plant, the country's largest source of heavy water, throws some light on the unfortunate situation, which also affects the country's credibility. We can ill afford this.

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IRAN

Secret Agreement With Pakistan Revealed

53004505 Kuwait AL-WATAN in Arabic 13 Jun 88 p 1

[Text] Yesterday the weekly British OBSERVER confirmed that Iran and Pakistan signed a secret nuclear cooperation agreement which would allow Iranian engineers in particular, to develop their skills in Pakistan.

According to the OBSERVER, who did not name their sources, this agreement took place last year in Geneva between Reza Amrollahi, chairman of the Iranian Atomic Energy Organization, and his Pakistani counterpart, Munir Ahmad Khan. The OBSERVER added that in accordance with this agreement, six Iranian engineers are currently residing in Pakistan.

The OBSERVER explained that in 1985, the regime in Teheran decided to resume its nuclear program, but to a lesser degree than what the Shah of Iran had been planning before the outbreak of the Iranian revolution.

PAKISTAN

Indian-Israeli Collusion Sparks 'Serious Concern'

BK2406025988 Islamabad Domestic Service in Urdu 0200 GMT 24 Jun 88

[Text] Pakistan has expressed serious concern at the recent reports published in the international press about increased possibility of India-Israel collusion to attack Pakistan's nuclear installations. The reports justifiably arouse concern in Pakistan as well as among its friend abroad in the wake of a prospective upgrading of Indian-Israeli relations. Pakistan is fully cognizant of its responsibilities and has taken all the necessary measures to effectively defend its nuclear installations. It will not countenance any act of aggression and the would be aggressor will be made to pay a heavy price for its adventurism.

It may be recalled that Pakistan and India had reached an understanding on not attacking each other's nuclear installations which was announced at a joint news conference in New Delhi in December 1985 by the Pakistani president and the Indian prime minister. Both countries are now engaged in producing the written form of this verbal understanding.

Indian leaders, without any basis in fact, have also kept repeating their allegations of Pakistan's involvement in India's internal affairs. Pakistan has categorically stated on several occasions that it strictly adheres to the policy of noninterference in the internal affairs of other countries.

Pakistan also regrets that Indian leaders, without bothering to ascertain the facts, are repeating unsubstantiated Kabul-Moscow allegations of Pakistan's violation of the Geneva accord on Afghanistan. Rather than this, it is imperative for the promotion of peace and good-neighborliness that India respond positively to Pakistan's constructive efforts to normalize relations.

Commentary on 'Strike' Plan

BK2206090988 Islamabad Domestic Service in English 1600 GMT 21 Jun 88

[Ghani Erabi commentary]

[Text] An American paper, THE NEW YORK TRIBUNE, [as received] has exposed the inside story of a deal between the Indian prime minister and Jewish leaders in the United States led by Congressman Stephen Solarz at their 8 June meeting in New York. The weekend paper claims in return for India's upgrading of its diplomatic relations with Israel, the Jewish leaders would use their influence to rein in Washington's military assistance to Islamabad. But more serious is THE TRIBUNE report that India's primary aim in improving relations with Israel is to seek what the paper called Israeli help in blunting Pakistan's nuclear program with, perhaps, a joint plan of action.

Both India and Israel have long thought to knock out Pakistan's nuclear installations, lest the so-called Islamic bomb challenges Israel's hegemony in the Middle East and India's in South Asia. Both possess their own bombs in the basement, but neither wants any other country in the region to acquire nuclear capability. This community of interest has brought them together in a plan to launch

a preemptive strike against Pakistan. Having successfully made such a strike against Iraq's nuclear reactor outside Baghdad in 1981, Israel claims the edge of military know-how, but India has the advantage of proximity to the target—less than 100 miles through the maze of mountains from Srinagar to Kahuta.

Both Israel and India have secretly assessed prospects of a strike. Israel's Defense Minister Ariel Sharon in 1981 listed Pakistan as among those potentially confrontational states who Israel would not want to gain access to nuclear weapons. An American Jewish leader, Professor (Amot Perlumuta) [as received] made a special study of the Israeli threat to Pakistan and told a Washington seminar in 1985: Pakistan's nuclear development sharpens in the Israeli mind the boundaries of conflict. And while he did not think Israel was going to do another Baghdad, a lot depended, he thought, on who was in power in Israel. A [word indistinct] might think, he added ominously, Islamabad was only a few minutes away.

India's top secret plan to hit Kahuta leaked out to the world amid the pile of secret papers pilfered from the Indian prime minister's office and sold to the highest bidder. India's secret designs against Pakistan were disclosed to the U.S. Senate Intelligence Committee on 14 September 1984 and the disclosure shook the world. So seriously was the threat taken that the U.S. Administration set up an interagency task force to handle the Indian threat on a crisis footing.

There have also been reports in the world press from time to time of feelers by both India and Israel for coordination of efforts. There were stories of secret exchange of visits by Israel's Moshe Dayan and India's MP's, scientists, and military experts as evidence of an overall Indo-Israel desire to draw closer. An Israeli MP, Rabbi Me'ir Cohen, said in Washington some 2 years ago, India and Israel were working together on a plan to carry out strikes against Kahuta in fulfillment of their common interest to eliminate the threat of a Pakistani bomb.

However, the Indo-Israeli desire to hit Pakistan's nuclear facility has not materialized so far because of the Israeli refusal to go it alone and the Indian unwillingness to join the venture. India's reluctance stems from the fear that any Indian attack on Kahuta will trigger a series of counterstrikes by Pakistan against India's widespread nuclear installations that will release a deadly burst of Hiroshima style nuclear radiation.

President on Nuclear Program's 'Peaceful' Nature

BK1606114188 Islamabad Domestic Service in English 1100 GMT 16 Jun 88

[Text] President Mohammad Ziaul Haq has reiterated that Pakistan's nuclear program is entirely peaceful in nature and is solely directed at meeting the country's needs for socioeconomic development. He was inaugurating in Islamabad this morning the 13th international summer college on physics and contemporary needs which will hold its working sessions in Nathiagali.

The president said we are determined to go ahead with this program and resist all pressures in its way. We will ensure that the benefits of peaceful application of nuclear energy are available to the people of Pakistan in all sectors, including agriculture, medicine, industry, and energy. He pointed out that Pakistan is (?definitely) short of energy and the government has asked the Pakistan Atomic Energy Commission to establish the necessary infrastructure and facilities and acquire essential know-how for achieving a greater measure of self-reliance in the design and construction of nuclear power plants. This will help us meet our growing needs of electricity in future.

The president said Pakistan wants to see South Asia free from nuclear weapons and the threat of their use. He pointed out that Pakistan has consistently worked for the denuclearization of South Asia. He recalled Pakistan's proposal for declaring South Asia as a nuclear-free zone and most specific proposals at the bilateral level with India to promote and strengthen the nonproliferation regime in the region and eliminate nuclear weapons in South Asia.

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